



## Records of new and rare elasmobranchs from Taiwan

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### Abstract

Five new records of elasmobranchs collected from eastern Taiwan fish markets, Da-xi and Cheng-gong, are presented. Samples were caught by deep-sea longliners and bottom trawlers which operate in northeastern waters off Taiwan between 2004 and 2012. These five new species records include the smalltooth sandtiger, *Odontaspis ferox* (Risso, 1810) (Lamniformes: Odontaspidae), salamander shark, *Parmaturus pilosus* Garman, 1906 (Carcharhiniformes: Scyliorhinidae), leadhued skate *Notoraja tobitukai* (Hiyama, 1940) (Rajiformes: Arhynchobatidae), giant skate *Dipturus gigas* (Ishiyama, 1958) (Rajiformes: Rajidae), and the pelagic stingray *Pteroplatytrygon violacea* (Bonaparte, 1832) (Myliobatiformes: Dasyatidae). Diagnostic characteristics for each species are given and a key to the genera *Parmaturus* and *Dipturus* from Taiwan is presented.

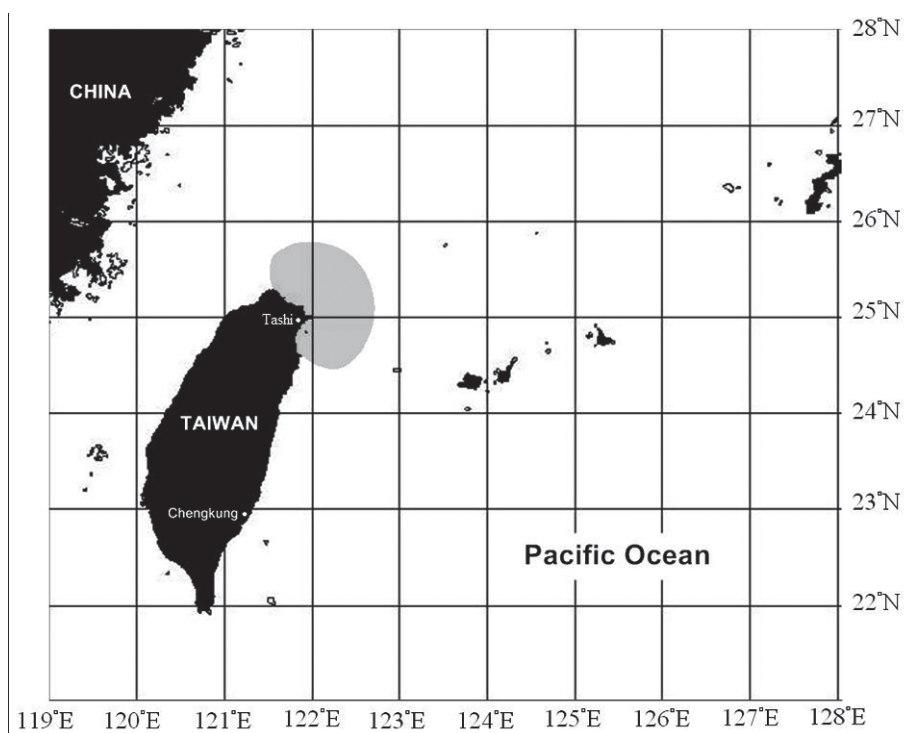
**Key words:** Deep-sea fishes, elasmobranchs, new records, Taiwan

### Introduction

The chondrichthyan fishes (sharks, skates, rays, and chimaeras) are high trophic level predators in most marine ecosystems and in Taiwan also provide an important food and fishmeal resource (Chen *et al.*, 1996; Hsu & Joun, 2004). However, declining fishery resources in Taiwanese waters have forced some fisheries, such as trawlers and long-liners, to operate in deeper waters. Thus, as deep-sea fisheries have expanded over the past decade, new records, and occasionally new or rare species, of chondrichthyans have been identified and reported in Taiwanese waters (Hsu & Joun, 2004; Haas & Ebert, 2006; Schaaf-Da Silva & Ebert, 2006; Lee & Shao, 2009, 2010; Knuckey *et al.*, 2011; White & Iglésias, 2011). As part of an ecological and morphological study on the fauna of chondrichthyan fishes in Taiwanese waters, an extensive as well as intensive collection of chondrichthyan fishes has been conducted since 2003 (Hsu & Joun 2004). As a result, five species not previously recorded from Taiwanese eastern waters were collected; this includes three genera (*Odontaspis*, *Notoraja*, and *Pteroplatytrygon*) not previously known to occur in this region. These five species are all little known deep-water chondrichthyan fishes, and includes *Odontaspis ferox* (Risso, 1810), *Parmaturus pilosus* Garman, 1906, *Notoraja tobitukai* (Hiyama, 1940), *Dipturus gigas* (Ishiyama, 1958), and *Pteroplatytrygon violacea* (Bonaparte, 1832). Here we report on these new records, and provide diagnostic characteristics of each new record. A key to the genera *Parmaturus* and *Dipturus* in Taiwanese waters is also provided.

## Methods

Specimens of *Parmaturus pilosus* were caught by a deep-sea long-liner from the northeastern waters off Taiwan and landed at the Cheng-gong fish market in April 2012 (Figure 1). The other species were caught by bottom trawlers also operating in waters off northeastern Taiwan and landed at Da-xi fish market, north of Cheng-gong from 2004–2010 (Figure 1). Those fishing vessels operated at depths greater than 200 m based on interviews with the captains and crew of the vessels. Morphological measurements and data follow those of Compagno (1984, 2001), Ishihara (1987), and Carpenter & Niem (1999). All specimens, except for one of the *Notoraja tobitukai* specimens, were preserved and deposited in the Department of Environmental Biology and Fisheries Science (EBFS), National Taiwan Ocean University.



**FIGURE 1.** Fishing ground (grey area) of deep-sea longliners and bottom trawlers that land at Da-xi or Cheng-gong markets.

## Results

### *Odontaspis ferox* (Risso, 1810)

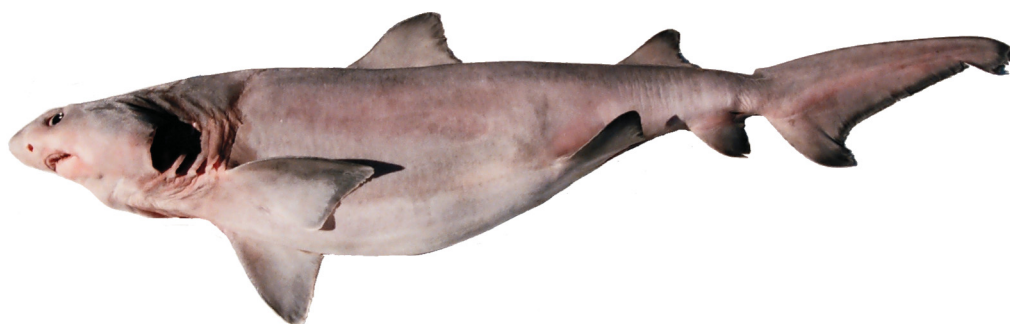
Smalltooth sandtiger

(Figure 2)

*Squalus ferox* Risso, 1810 (Ichthyol. Nice, Paris: 38; type locality: off Nice, France, in the Mediterranean Sea).

**Material examined.** (2 specimens). EBFS020203010201-1, >300 cm TL, mature female, Da-xi, April 2004; this individual was bought by a fish buyer after landing but the jaws were kept for research. EBFS020203010201-2, 100.9 cm TL, neonatal female, abdomen scar present, Da-xi, June 2004.

**Diagnosis.** Body fusiform, moderately stout; medium grey in young, darker grey-brown in adult, lighter below, with darker dusky spots on sides of some individuals; fins dusky with blackish edges in young but uniform dusky in adults, first dorsal fin without a white blotch; caudal peduncle without keels. Pectoral fins angular. First dorsal apex subangular in adults. Anal fin height 4.6 to 6.0% of total length. Anal fin with strongly concave posterior margin. Caudal fin with ventral caudal lobe short but stout. Teeth similar in both jaws; two to five (mostly four) rows of small intermediate teeth between upper anterior and lateral tooth rows; a pair of upper and a pair of lower symphyseal teeth present; tooth rows numerous, 48 to 56/36 to 46 (88 to 102 total); root lobes of anterolateral teeth deeply arched and narrow; anterolateral teeth usually with 2 or 3 pairs of lateral cusplets.



**FIGURE 2.** Specimen of smalltooth sandtiger *Odontaspis ferox*, female, 100.9 cm TL, EBFS020203010201-2, Da-xi, June 2004.

**Distribution.** Circumglobal, but patchily distributed. Western Pacific records in addition to the new record for Taiwan includes southern Japan, New South Wales Australia, and New Zealand.

### ***Parmaturus pilosus* Garman, 1906**

Salamander shark

(Figures 3, 4)

*Parmaturus pilosus* Garman, 1906 (Bull. Mus. Comp. Zool. Harvard, 46(11): 204; type locality: 34°59'N, 139°31'E, Sagami Bay, Japan).

**Material examined.** (2 specimens). EBFS020204010602-1, 58.8 cm TL, mature female, Cheng-gong, April 2012. EBFS020204010602-2, 60.1 cm TL, mature female, Cheng-gong, April 2012. Egg capsule 1: 79.55 mm × 30.76 mm × 15.68 mm with a 37.42 mm × 27.10 mm oval egg (Figure 3). Egg capsule 2: 76.52 mm × 19.28 mm × 14.47 mm with a 40.74 mm × 18.35 mm columned egg. Five specimens were obtained from a fish buyer, but three individuals were processed and sold, while two others were kept for research; two egg capsules (EBFS020204010602-3) from 1 of 3 processed individuals were also retained and are deposited with the two intact specimens.

**Diagnosis.** Snout moderately short and broadly rounded, 2/3 of mouth width; nasal flaps large, narrow-based and lobate; gill septa not excavated and concave posteriorly. First dorsal fin about as large as second; first dorsal origin just behind pelvic origins; first dorsal insertion slightly behind pelvic insertions; second dorsal smaller than anal fin; second dorsal origin well behind anal origin; second dorsal insertion about over anal insertion; ventral edge of caudal peduncle and preentral caudal margin with a crest of enlarged denticles.

**Distribution.** Known previously from off southern Japan, these new records extends its geographic range to the deep waters off northeastern Taiwan.

### **Key to species of *Parmaturus* Garman, 1906 occurring in Taiwanese waters**

- 1a. Origin of first dorsal well behind pelvic origins ..... *P. melanobranchius*
- 1b. Origin of first dorsal nearly or quite opposite pelvic origins ..... *P. pilosus*



**FIGURE 3.** Specimen of salamander shark *Parmaturus pilosus*, female, 58.8 cm TL, EBFS020204010602-1, Cheng-gong, April 2012.



**FIGURE 4.** Egg capsule of *Parmaturus pilosus*, 79.55 mm × 30.76 mm × 15.68 mm with a 37.42 mm × 27.10 mm oval egg.

***Notoraja tobitukai* (Hiyama, 1940)**

Leadhued skate

(Figure 5)

*Raja tobitukai* Hiyama, 1940 (Japan. J. Zool.: 169, fig. 1.; type locality: Kumano-Nada, Japan).

*Breviraja tobitukai*: Huang, 2001: 404-463.

**Material examined.** (2 specimens). EBFS020212040401-1, 43.6 cm TL, mature female, Da-xi, December 2004; CAS 235281, 43 cm TL, mature female, Da-xi, May 2005.

**Diagnosis.** Snout flexible; rostral cartilage either absent, incomplete, rod-like or very narrow with its width not exceeding its depth; no thorn on scapular and nuchal regions; tail thorns absent or very weak; dermal denticles uniformly distributed on dorsal side of disc. Disc grayish on both sides.

**Distribution.** South China Sea, Taiwan, East China Sea to southern waters off Japan. This species has previously been reported from the South China Sea, off southern Taiwan (Shao *et al.*, 2008), but these new records represent the first from off northern Taiwan.



**FIGURE 5.** Specimen of leadhued skate *Notoraja tobitukai*, female, 43.6 cm TL, EBFS020212040401-1, Da-xi, December 2004.



***Dipturus gigas* (Ishiyama, 1958)**

Giant skate

(Figure 6)

*Dipturus gigas* Ishiyama, 1958 (J. Shimonoseki Coll. Fisher., 7: 386 figs. 84, 86; type locality: Aichi, Japan).

**Material examined.** (2 specimens). EBFS020212040301-1, 20.6 cm total length (TL), juvenile male, Da-xi, January 2004; EBFS020212040301-2, 32.3 cm TL, juvenile female, Da-xi, March 2004.

**Diagnosis.** Snout with well-defined, firm rostral cartilage; disc somewhat angular; snout medium to elongate, distinctly angular anteriorly; rostral cartilage long, mostly exceeding 60% dorsal head length; adult clasper lacking a projecting distal cartilage. In adults, snout long; its length more than 1/2 the distance from snout tip to fifth gill opening. Tail short; disc width more than 1.5 times tail length. Pelvic anterior lobe long, reaching beyond middle of posterior lobe. Both sides of disc and tail uniformly dark purplish-brown or grayish-brown.

**Distribution.** South China Sea, Taiwan, East China Sea to Japan waters in 300–1000 m deep.

**Key to species of *Dipturus* (Rafinesque, 1810) in the Taiwanese waters**

- 1a. Both sides of disc and tail uniformly dark purplish-brown or grayish-brown; dorsals usually set close together; anterior lobe of pelvics long, inserting very deep notch; in adults, prickles covering dorsal side of disc also beyond snout, and covering almost entire ventral side of disc ..... *D. gigas*
- 1b. Dorsal side of body dark brown, ventral side lighter; dorsals widely separated; anterior lobe of pelvics short, inserting shallow notch; even in adults, prickles covering only both surface of snout and/or skin posterior to gill slits ..... 2
- 2a. Dorsal side of disc mottled with many light marks of various sizes; a pair at center of pectorals largest of these; prickles absent on skin posterior to gill slits; ventral sensory pores never extended rearwards to areas lateral to cloaca ..... *D. kwangtungensis*
- 2b. Dorsal side of disc with faint color marks or plain colored; prickles present on skin posterior to gill slits; ventral sensory pores extended to areas lateral to cloaca. .... 3
- 3a. Lateral tail folds rather indistinct; tail gradually tapering rearwards; snout extremely pointed, dorsal head length more than 6.5 times the interorbital width and margins of snout tip almost parallel; postdorsal tail length more than 80% of second dorsal base length ..... *D. tengu*
- 3b. Lateral tail folds distinct; tail expanded laterally at midlength; snout less pointed, dorsal head length less than 6.5 times the interorbital width and margins of snout tip diagonal: postdorsal tail length less than 80% of second dorsal base length ..... *D. macrocauda*



**FIGURE 6.** Specimen of giant skate *Dipturus gigas*, female, 32.3 cm TL, EBFS020212040301-2, Da-xi, March 2004.

***Pteroplatytrygon violacea* (Bonaparte, 1832)**

Pelagic stingray

(Figure 7)

**Material examined.** (2 specimen). EBFS020213050401-1, 96.7 cm TL, mature female, Da-xi, December 2005. NMMBP020466, 65 cm TL, juvenile female, Da-xi, July 2010.

**Diagnosis.** A dark, medium-sized stingray with an evenly rounded anterior disc margin; a dark ventral surface; small thorns in a continuous row along the back; a whip-like tail with a long ventral fold; dorsal fold or ridge absent, or very weak when present. Mouth small with 8–12 short, bifurcated papillae in a continuous row across floor; labial furrows and folds prominent; lower jaw weakly convex. Tail exceeding twice length of disc; broad-based, tapering, slightly depressed in cross-section anteriorly, whip-like beyond sting; 1–2 stings; ventral cutaneous fold low, elongate, extending for about half to three-quarters of tail length beyond sting.

**Distribution.** Tropical and subtropical seas, including Eastern Atlantic, Western Atlantic, East Pacific, Japan and Taiwan of the northwestern Pacific at depths of 1–381 m (usually <100 m).



**FIGURE 7.** Specimen of pelagic stingray *Pteroplatytrygon violacea*, female, 96.7 cm TL, EBFS020213050401-1, Da-xi, December 2005.

## Discussion

These five species have all previously been reported from Japanese waters (Masuda *et al.*, 1984; Ishihara, 1987; Nakaya & Shirai, 1992), and the three batoid species have also been recorded from Chinese waters (Zhu & Meng, 2001), indicating that these elasmobranchs would not be unexpected to find in Taiwanese waters. However, a large biomass of species often taken as bycatch and considered to be “trash fish” is processed for fishmeal or discarded, without any further identification, in Taiwan. Due to insufficient human and technical resources for collecting and identifying samples, many species were missed or misidentified.

In addition to the batoid fishes, large juvenile shark species, e.g. including the pelagic thresher (*Alopias pelagicus*), scalloped hammerhead (*Sphyrna lewini*), smooth hammerhead (*S. zygaena*), whale shark (*Rhincodon typus*), and goblin shark (*Mitsukurina owstoni*), are frequently caught by trawlers, but are usually unreported (Lee & Shao, 2009; Hsu *et al.*, 2012; H.H. Hsu pers. obs.). Da-xi is the largest trawl fishery fish market in Taiwan. A mature female and neonate specimen of *Odontaspis ferox* were found in a very short period, suggesting that trawl fishing ground in the northeastern waters off Taiwan might serve as a breeding and feeding ground for some larger shark pups.

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## References

- Carpenter, K.E. & Niem, V.H. (Eds.) (1999) *FAO Species Identification Guide for Fishery Purposes. The living marine resources of the Western Central Pacific. Batoid fishes, chimaeras and bony fishes part 1 (Elopidae to Linophrynidae). Vol. 3.* FAO, Rome, pp. 1397–2068.
- Chapman, D.D.F., Pikitch, E.K. & Babcock, E.A. (2006) Marine parks need sharks? *Science*, 312, 526–527.
- Chen, G.C.T., Liu, K.M., Joung S.J. & Phipps, M.J. (1996) *Shark fisheries and trade in Taiwan*. Project report, TRAFFIC East Asia-Taipei, Taipei, 48pp.
- Compagno, L.J.V. (1984) *FAO Species Catalogue. Vol. 4. Sharks of the World. An annotated and illustrated catalogue of shark species known to date.* FAO Fisheries Synopsis No. 125, Part 1 (Hexanchiformes to Lamniformes), 1–250; Part 2 (Carcharhiniformes), 251–655.
- Compagno, L.J.V. (2001) *FAO Species Catalogue for Fishery Purposes. No. 1, Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes).* FAO, Rome, 269 pp.
- Haas, D.L. & Ebert, D.A. (2006) *Torpedo formosa* sp. nov., a new species of electric ray (Chondrichthyes: Torpediniformes: Torpedinidae) from Taiwan. *Zootaxa*, 1320, 1–14.
- Hsu, H.H. & Joung, S.J. (2004) Four new records of cartilaginous fishes from Taiwan. *Journal of the Fisheries Society of Taiwan*, 31, 183–189.
- Hsu, H.H., Joung, S.J. & Liu, K.M. (2012) Fisheries, management, and conservation of the whale shark *Rhincodon typus* in Taiwan. *Journal of Fish Biology*, 80, 1595–1607.  
<http://dx.doi.org/10.1111/j.1095-8649.2012.03234.x>
- Ishihara, H. (1987) Revision of the western North Pacific species of the genus *Raja*. *Japanese Journal of Ichthyology*, 34, 241–540.
- Knuckey, J.D.S., Ebert, D.A. & Burgess, G.H. (2011) *Etmopterus jouni* n. sp., a new species of lanternshark (Squaliformes: Etmopteridae) from Taiwan. *Aqua, International Journal of Ichthyology*, 17, 61–72.
- Last, P.R. & Stevens, J.D. (1994) *Sharks and rays of Australia*. CSIRO Australia, Melbourne, 599 pp.
- Lee, P.F. & Shao, K.T. (2009) Two new records of Lamniform shark from the waters adjacent to Taiwan. *Journal of the Fisheries Society of Taiwan*, 36, 303–311.
- Lee, P.F. & Shao, K.T. (2010) New record of the rare shark *Parmaturus melanobranchius* (Scyliorhinidae) from Taiwan. *Taiwania*, 55, 386–390.
- Masuda, H., Amaoka, K., Araga, C., Uyeno, T. & Yoshino, T. (1984) *The fishes of the Japanese archipelago*. Tokai University Press, Tokyo, 437 pp.
- Nakaya, K. & Shirai, S. (1992) Fauna and zoogeography of deep-benthic chondrichthyan fishes around the Japanese archipelago. *Japanese Journal of Ichthyology*, 39, 37–48.
- Schaaf-Da Silva, J.A. & Ebert, D.A. (2006) *Etmopterus burgessi* sp. nov., a new species of lanternshark (Squaliformes: Etmopteridae) from Taiwan. *Zootaxa*, 1373, 53–64.
- Shao, K.T., Ho, H.C., Lin, P.L., Lee, P.F., Lee, M.Y., Tsai, C.Y., Liao, Y.C., Lin, Y.C., Chen, J.P. & Yeh, H.M. (2008) A checklist of the fishes of southern Taiwan, northern South China Sea. *The Raffles Bulletin of Zoology*, 19, 233–271.
- White, W.T. & Iglésias, S.P. (2011) *Squalus formosus*, a new species of spurdog shark (Squaliformes: Squalidae), from the western North Pacific Ocean. *Journal of Fish Biology*, 79, 954–968.  
<http://dx.doi.org/10.1111/j.1095-8649.2011.03068.x>
- Zhu, Y.D. & Meng, Q.W. (2001) *Fauna Sinica, Cyclostomata and Chondrichthyes*. Science Press, Beijing, 552 pp. [in Chinese]